SK1231 User Guide

Evaluation board for Drop-In RF Transceiver Modules

GENERAL DESCRIPTION

The SK1231 is an advanced development tool to kick start your wireless project. It is powered by a strong STM32F4 microcontroller to support all kinds of applications what gives the developer high flexibility for possible applications. The board can be controlled via GUI, this software is easy to use and offers a fast way to find the right RF settings for a specific device. The second way of controlling the DP1231 Module is changing and debugging the firmware

SUPPORTED MODULES

The **DP1231** is a low cost transceiver module operating in the frequency ranges from 290-340 MHz, 424-510, 862-1020 MHz. The DP1231 is optimized for High Link Budget and for very small form factor. It incorporates a baseband modem with data rates up to 300 kb/s. Data handling features include a 66 byte FIFO, packet handling, automatic CRC generation and data whitening. All major RF communication parameters are programmable and most of them may be dynamically set. It complies with European (ETSI EN 300-220 V2.1.1) and North American (FCC part 15) regulatory standards.

Packing List

- 2x EM1200 Board
- 2x EM1231 Board
- 2x Antennas
- 2x USB cable
- 1x CDROM with the installation files and the user guide

DEVICE OPTIONS

Part	Frequency band
SK1231C315	290 - 340 MHz
SK1231C433	424 - 510 MHz
SK1231C868	862 - 902 MHz
SK1231C915	902 - 1020 MHz

RECOMMENDED READING

- Datasheet for DP1231
- Datasheet for Semtech SX1231

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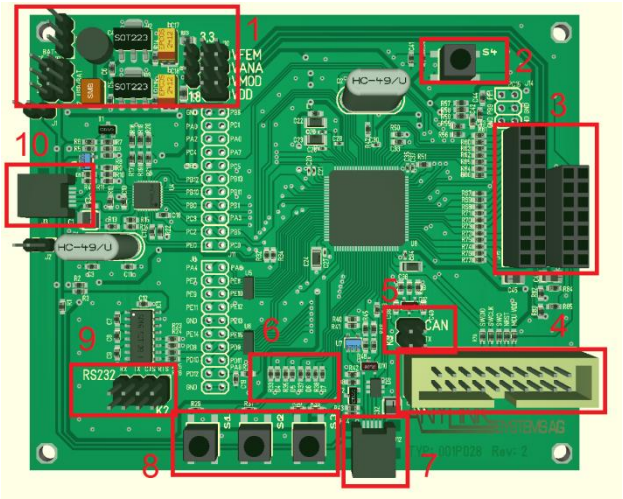
1 EVALUATION BOARD OVERVIEW

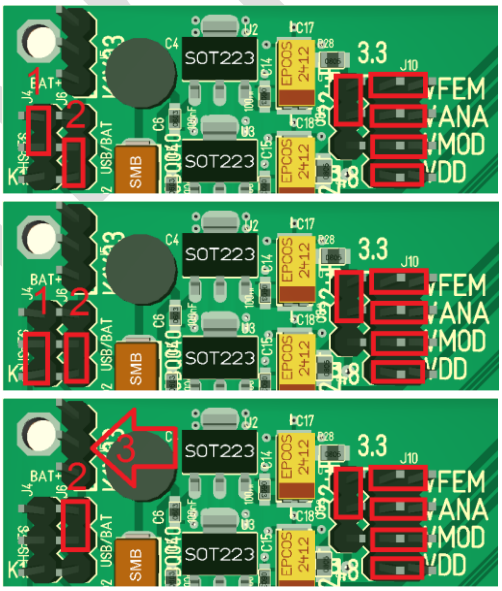
1: Power Supply
2: Reset
3: RF-Module
4: MCU debugger/programmer (ST-LINK/V2)
5: CAN (software not implemented)
6: LED indicator
7: USB / Full Speed
8: GPIO Buttons
9: RS232 (software not implemented)
10: Power via USB (only for power)



1.1 Power supply options

Configure the jumper as the red marks show it.

- USB/ FS (7)
- Separate USB only for power (10)
- Extern 5 – 12 V



The three pin header on the left side enable the user to setup the wanted power supply configuration. The pin header with the marking FS/HS decides if USB /FS (7) or power via USB (10) is used. If the Jumper (1) is plugged on the upper to pins Power is supplied from USB/FS (7) and if plugged on the lower pins power via USB (10) is used.
For an external power supply the upper three pin header (3) has to be used marked with the red arrow. The marking BAT+ show the pin for positive power and the other two are grounded and can be used for the negative power supply. If this option is selected the three pin header (2) below has to be fitted with a jumper in the upper position. The marking on this pin header show USB / BAT for the two USB options or the external power supply.

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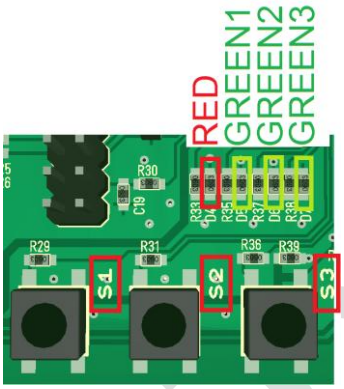
1.2 Button and LED description

The evaluation board EM1200 has several buttons to interact with the firmware running on it.

Button S1: The button saves the current running register setting for the RF chip to the MCU flash memory. If the board is reset by power off or pressing the reset button the MCU load the register setting from the flash memory.

Button S2: This button is switching manually between master and slave modes see stand alone mode (Chapter 2.) for more details.

Button S3: Initialization of a default register setting for the RF Chip in the GUI this function is called recommended settings.



Furthermore the board has four LEDs to indicate RF processing and present USB connection.

LED RED: RF missed packet

LED GREEN1: RF data packet transmit

LED GREEN2: RF data packet received

LED GREEN3: USB is active

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1.3 RF-Module Connector

The RF-Module connector is the interface to the RF-Modul. The Modul is held by an adaptor PCB that fit into the connector socket. For detailed information about the pinout have a look at the Tables below.

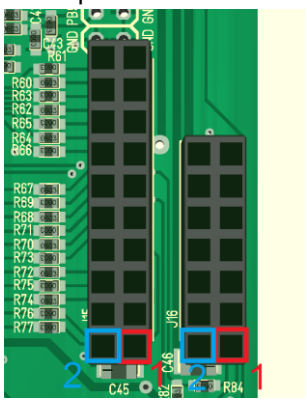

Table of 20 Pin Socket:

Pin no.:	MCU GPIO	DP1231	Description
1	PC10	SCK	SPI clock
2	-	VDD	power supply VDD_MOD
3	PC12	MOSI	SPI master out slave in
4	-	GND	power supply GND
5	PD3	DIO1	Digital I/O, software configured
6	PD2	DIO3	Digital I/O, software configured
7	PA15	NSS	SPI chip select
8	PC11	MISO	SPI master out slave in
9	PD5	DIO5	Digital I/O, software configured
10	PD4	RESET	Manual reset
11	PD7	DIO4	Digital I/O, software configured
12	PD6	DIO0	Digital I/O, software configured
13	PE2	NC	not connected
14	PB4	NC	not connected
15	PE4	RXTX	Indicator for RX or TX mode
16	PE3	NC	not connected
17	PE6	DIO2	Digital I/O, software configured
18	PE5	NC	not connected
19	PC14	NC	not connected
20	PC13	NC	not connected

For the DP1231 Module just the 20 Pin socket is used for communication. The 14 Pin Socket is for further Modules and possible updates.

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Table of 14 Pin Socket:

Pin no.:	MCU GPIO	DP1231	Description
1	PB7	NC	I2C SDA (optional)
2	-	NC	power supply VDD_ANA
3	PB6	NC	I2C SCL (optional)
4	-	NC	power supply GND
5	-	NC	not connected
6	-	NC	not connected
7	-	NC	not connected
8	-	NC	not connected
9	-	NC	not connected
10	-	NC	not connected
11	-	NC	not connected
12	-	NC	power supply GND
13	-	NC	not connected
14	-	NC	power supply VDD_FEM

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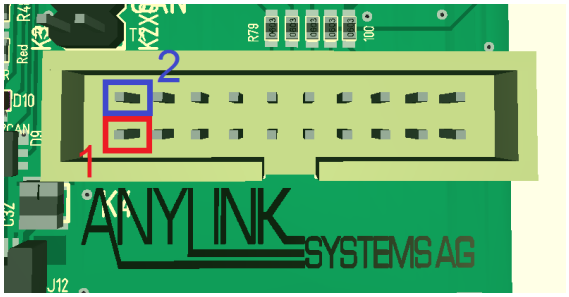
1.4 MCU debugger/programmer

The debugger/programmer connector is the standard shipped with the ST-Link/v2. It allows the user to reprogram the microcontroller with its own custom firmware and also test the firmware that comes with the EM1200. The microcontroller code is open and can be flashed from a free IDE (COOCOX CoIDE) that is easy to install and run.



Pin no.:	ST-LINK/V2	EM1200
1	VAPP	VDD
2	VAPP	NC
3	TRST	GND
4	GND	GND
5	TDI	GND
6	GND	GND
7	TMS_SWDIO	SWDIO
8	GND	GND
9	TCK_SWCLK	SWCLK
10	GND	GND
11	NC	NC
12	GND	GND
13	TDO_SWO	SWO
14	GND	GND
15	NRST	NRST
16	GND	GND
17	NC	NC
18	GND	GND
19	VDD	NC
20	GND	GND

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2 GETTING STARTED

2.1 STANDALONE MODE

The stand alone mode is applied if power supply is connected and no USB connection is present. USB connection is indicated by the flashing led GREEN3 “no Flashing = no Data transfer”.
In the Stand alone mode the device is programmed to work as ***Master*** device and transmitting data packets with a **PING** signature but also set itself in receive mode between the transmitting. If another ***Master*** device is present transmitting **PING** messages the first device to receive a **PING** switch in ***Slave*** mode Transmitting **PONG** messages. Switching between ***Master*** and ***Slave*** mode can also be done by pressing the s2 button. If a ***Master*** and ***Salve*** configuration is present the ***Master*** sends **PING** to ***Slave*** and is answered with **PONG**. As long as the ***Master*** is getting no **PONG** massage the RED LED is flashing. The LED GREEN1 show transmit and GREEN2 show receiving.
Pressing button S1 will save the current RF setting on the EM1200 device. This setting is applied at every reset and power on reset. Even a long power off - power on is not deleting the saved settings. Just a new saving event can overwrite the old settings, because they are saved in the microcontroller flash memory.
Pressing button S3 sets all RF setting to the software defined defaults equal to the GUI function *Recommended Settings*

2.2 SAVING SETTINGS ON THE STARTERKIT

Having the ability to save different register settings on the Starter kit, can be a very helpful tool for every Developer. That for the EM1200 Start kit is able to save four different register setting for the RF Chip. This Setting can be accessed via the buttons during the startup procedure after every Reset event.

2.2.1 Save Register Setting on the Starterkit

Start with creating a setting with the graphical user interface. If the GUI shows the right settings there is two ways how to save this setting.
One is to use the “Save on device” function in the “Configuration” menu. Simply press it and watch the RED LED light up for a second. Now you saved the setting in position one to use a differed position press S3 while the RED LED is on and it jumps to GREEN1, GREEN2 and GREEN3. Every LED stands for a different save position. Saving at the same position twice overnights the old register setting.
Second way to save is to press the Save button S1, the RED LED will also light up for a second with mean you saved at first position. Keeping the button S1 pressed and shortly pressing button S3 and you change the save position.

2.2.2 Load Register Setting on the Starterkit

Loading the saved Register setting is done automatically in the reset procedure. Save position one (RED LED) is default and can be changed by pressing button S3 while the RED LED is on. The other LEDs will light up one after another, if you reached the required position just let it finish start up and you done.

2.3 SOFTWARE INSTALLATION

2.3.1 EM12xx USER INTERFACE

Software installation on Windows 7.
The installation media also contains also the **Microsoft Visual Studio 2005 C Runtime** that must be installed on the target computer. Installation can be started by running “**vcdredist_x86/vcdredist_x86.exe**” on the installation media.
To install the **User Interface** starting the “**EM1200 Software.msi”** that can be found on the installation media.

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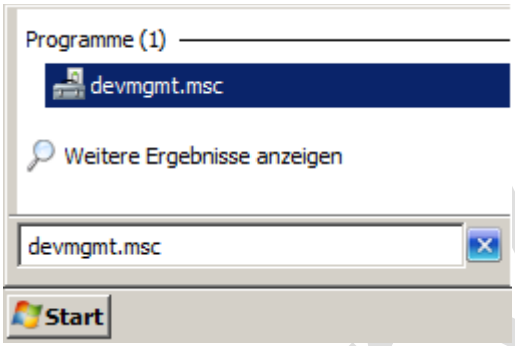
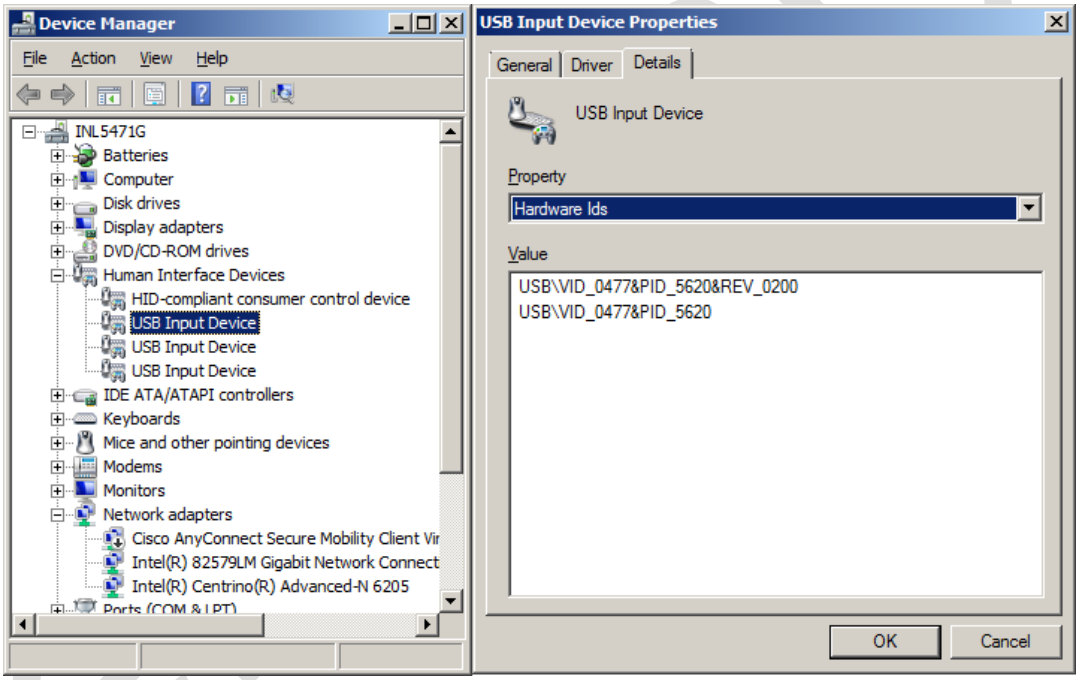
2.3.2 EM1200 DRIVER SETUP

The driver can only be installed while the EM1200 is connected.

The driver must be installed using the device manager. The device manager can be started from the Windows Start menu by running the command "**devmgmt.msc**"



The EM1200 Board identifies itself as USB Input device. The EM1200 can be identified with the following Hardware ID's.



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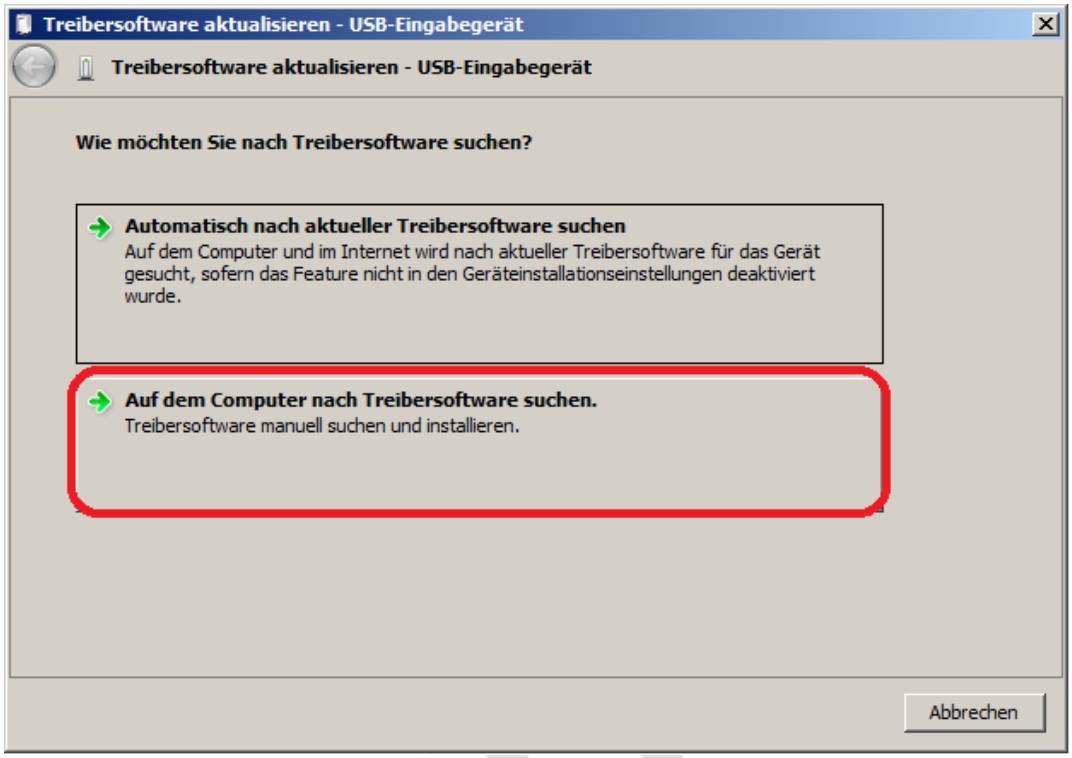
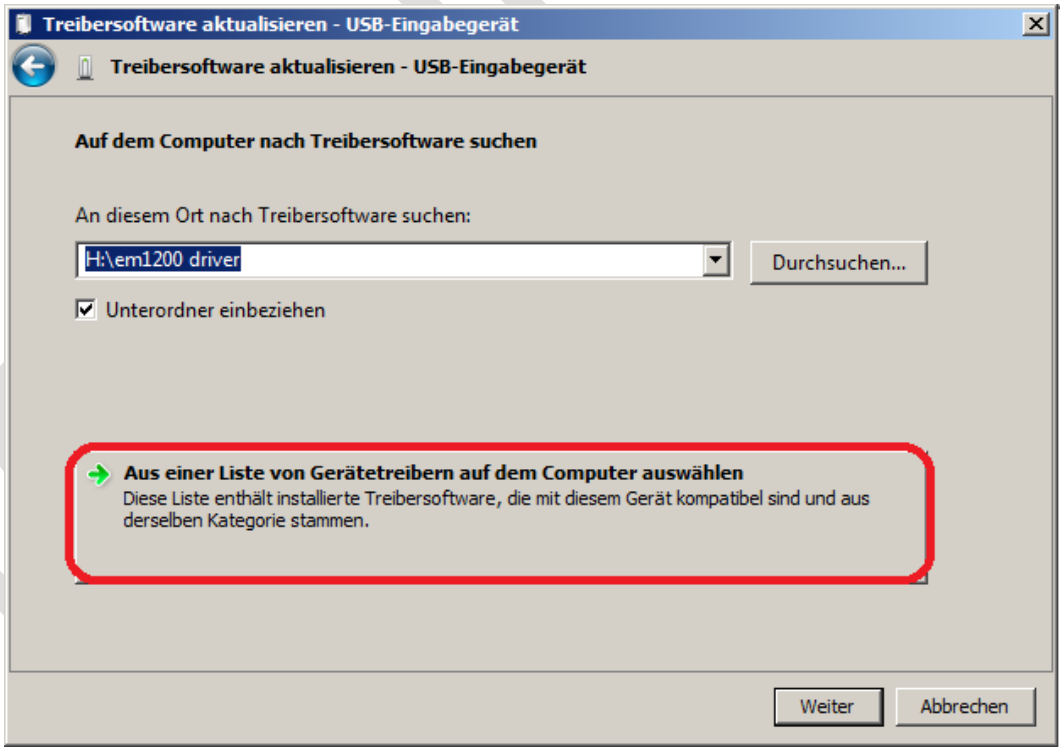
Select “**Brows computer for driver software**”

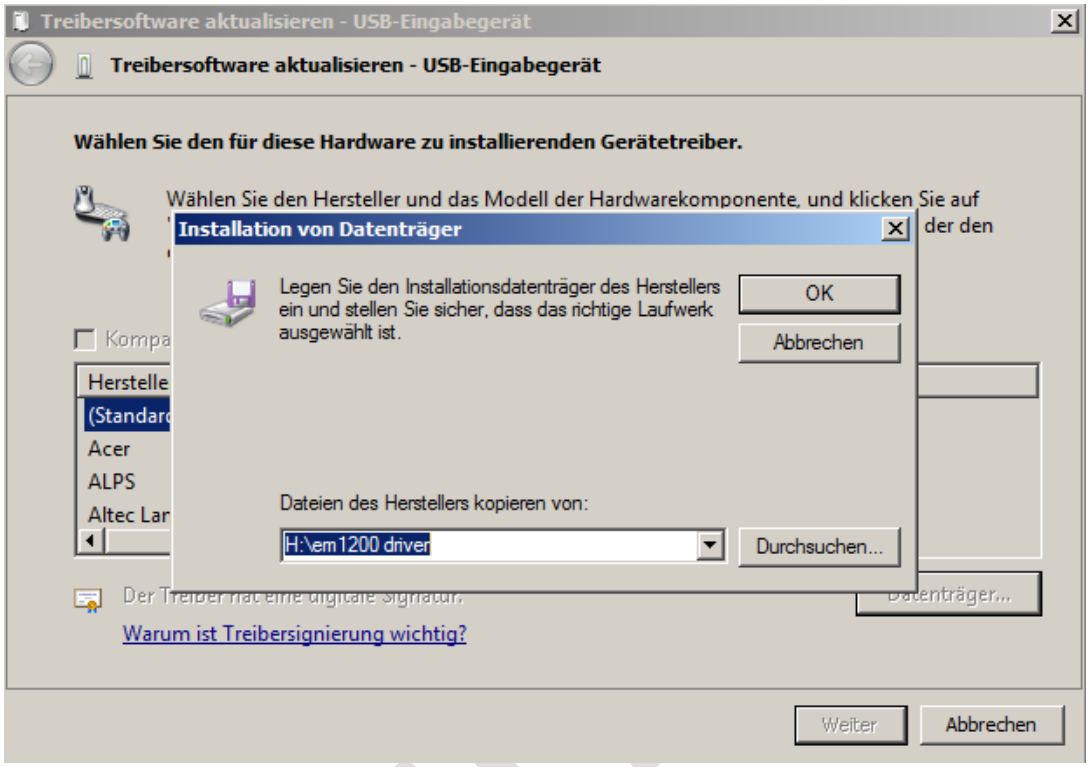

Treibersoftware aktualisieren - USB-Eingabegerät
Treibersoftware aktualisieren - USB-Eingabegerät
Wie möchten Sie nach Treibersoftware suchen?
Automatisch nach aktueller Treibersoftware suchen
Auf dem Computer und im Internet wird nach aktueller Treibersoftware für das Gerät gesucht, sofern das Feature nicht in den Geräteinstallationseinstellungen deaktiviert wurde.
Auf dem Computer nach Treibersoftware suchen.
Treibersoftware manuell suchen und installieren.
Abbrechen

Select “**Let me pick from a list of device drivers on my computer**”

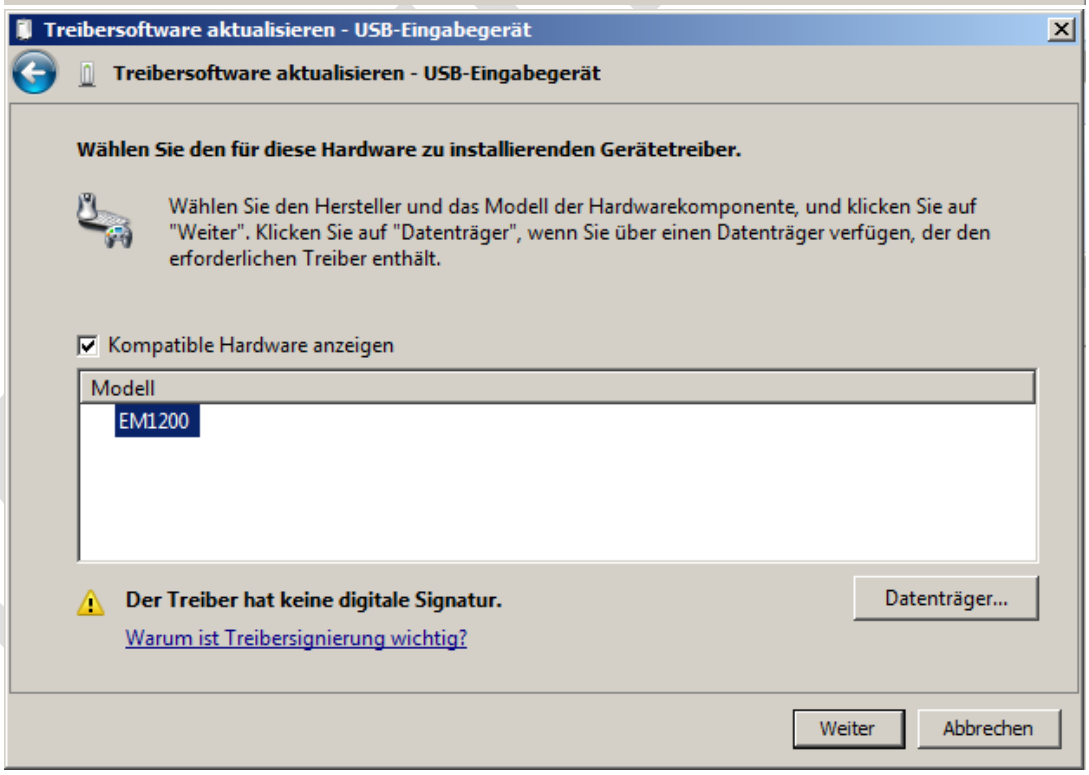

Treibersoftware aktualisieren - USB-Eingabegerät
Treibersoftware aktualisieren - USB-Eingabegerät
Auf dem Computer nach Treibersoftware suchen
An diesem Ort nach Treibersoftware suchen:
H:\em1200 driver
Durchsuchen...
Unterordner einbeziehen
Aus einer Liste von Gerätetreibern auf dem Computer auswählen
Diese Liste enthält installierte Treibersoftware, die mit diesem Gerät kompatibel sind und aus derselben Kategorie stammen.
Weiter
Abbrechen

Click on the “**Hard disk**” Button and brows to the EM1200 driver directory.

After installation of the User Interface the Driver for the USB Device can be found in the Installation Folder. With the default installation Path the driver can be found in.
“%PROGRAMFILES%\ANYLINK Systems\EM1200 Software\EM1200 driver”

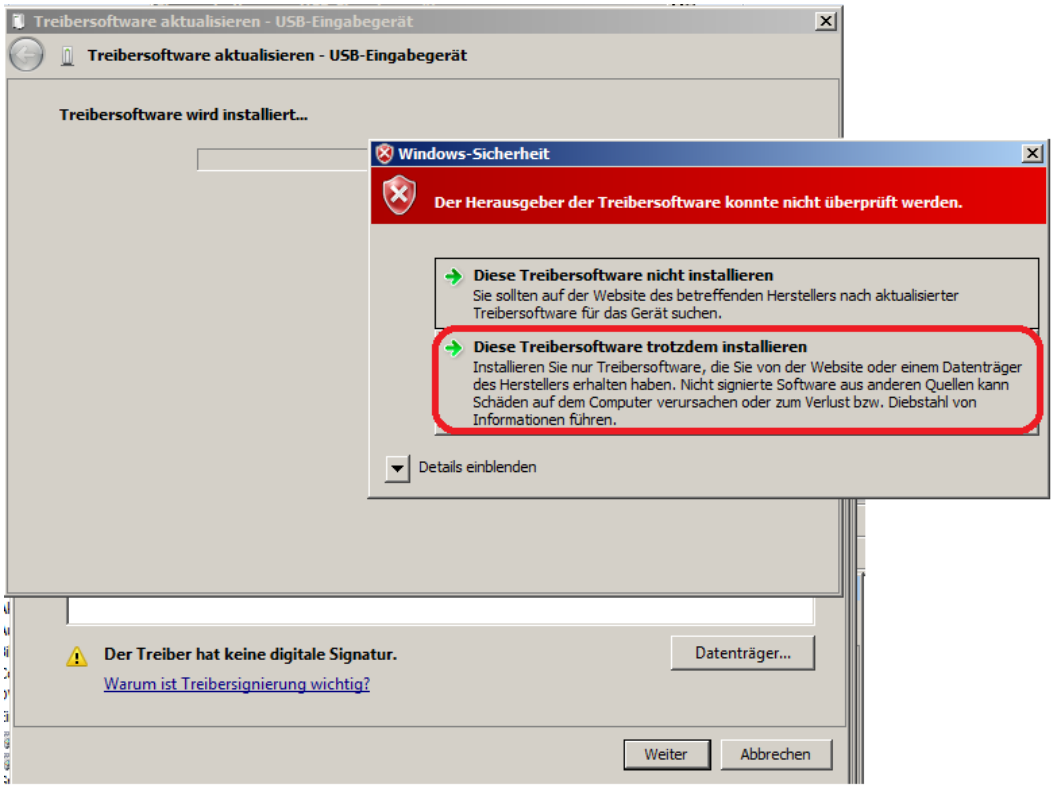


Select the EM1200 driver and click "**Continue**"

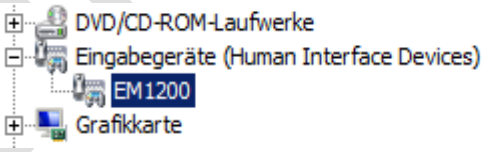

Treibersoftware aktualisieren - USB-Eingabegerät
Treibersoftware aktualisieren - USB-Eingabegerät
Wählen Sie den für diese Hardware zu installierenden Gerätetreiber.
Wählen Sie den Hersteller und das Modell der Hardwarekomponente, und klicken Sie auf "Weiter". Klicken Sie auf "Datenträger", wenn Sie über einen Datenträger verfügen, der den erforderlichen Treiber enthält.
Kompatible Hardware anzeigen
Modell
EM1200
Der Treiber hat keine digitale Signatur.
Datenträger...
Warum ist Treibersignierung wichtig?
Weiter
Abbrechen

pro

As the driver is unsigned, you will receive a warning during driver installation. To continue the driver installation click "**Install this driver anyway**".


Treibersoftware aktualisieren - USB-Eingabegerät
Treibersoftware aktualisieren - USB-Eingabegerät
Treibersoftware wird installiert...
Windows-Sicherheit
Der Herausgeber der Treibersoftware konnte nicht überprüft werden.
Diese Treibersoftware nicht installieren
Sie sollten auf der Website des betreffenden Herstellers nach aktualisierter Treibersoftware für das Gerät suchen.
Diese Treibersoftware trotzdem installieren
Installieren Sie nur Treibersoftware, die Sie von der Website oder einem Datenträger des Herstellers erhalten haben. Nicht signierte Software aus anderen Quellen kann Schäden auf dem Computer verursachen oder zum Verlust bzw. Diebstahl von Informationen führen.
Details einblenden
Der Treiber hat keine digitale Signatur.
Warum ist Treibersignierung wichtig?
Datenträger...
Weiter
Abbrechen

After successful installation of the driver, the device should show up in the Device Manager as EM1200.



2.3.3 SAMPLE CONFIGURATIONS

You can find sample configurations for different applications of the modules in the installation directory and on the installation media.

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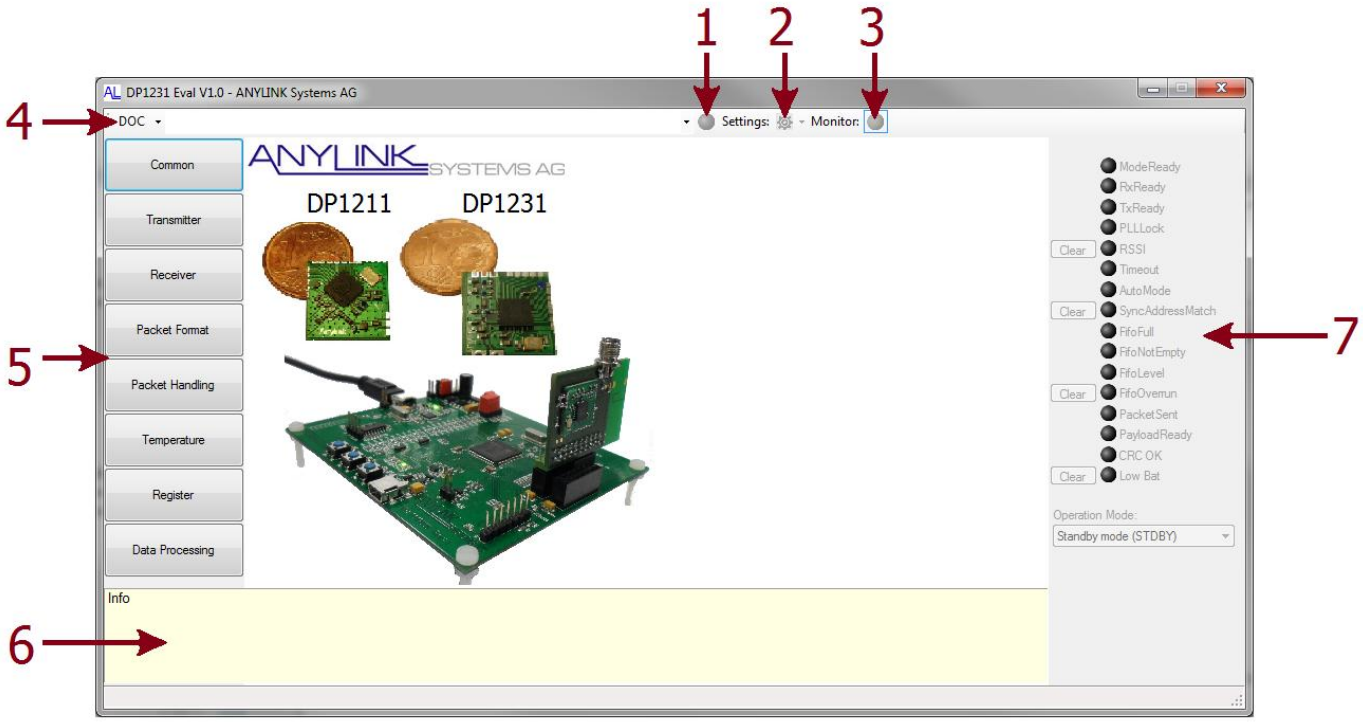
3 DP1231 USER INTERFACE DESCRIPTION

3.1 OVERVIEW



1. **Connect Button –** Blue indicates that the EM1200 is connected Gray indicates that the EM1200 is disconnected.
2. **Settings Menu** – Allows saving and loading of register settings.
3. **Monitor Button** – Enables/Disable register monitoring, if enabled all readable Register values are continually read from the module and the user interface is updated according to this values.
4. **Documentation shortcuts** can be found in this Dropdown menu
5. **Configuration Sections** – Gives access to the different configuration options for the module the first click will display the specified section, a second click will move the configuration options in a separate window.
6. Information – Gives information about the current selected configuration element.
7. Operation Mode and Interrupt Monitoring – Monitoring must be enabled

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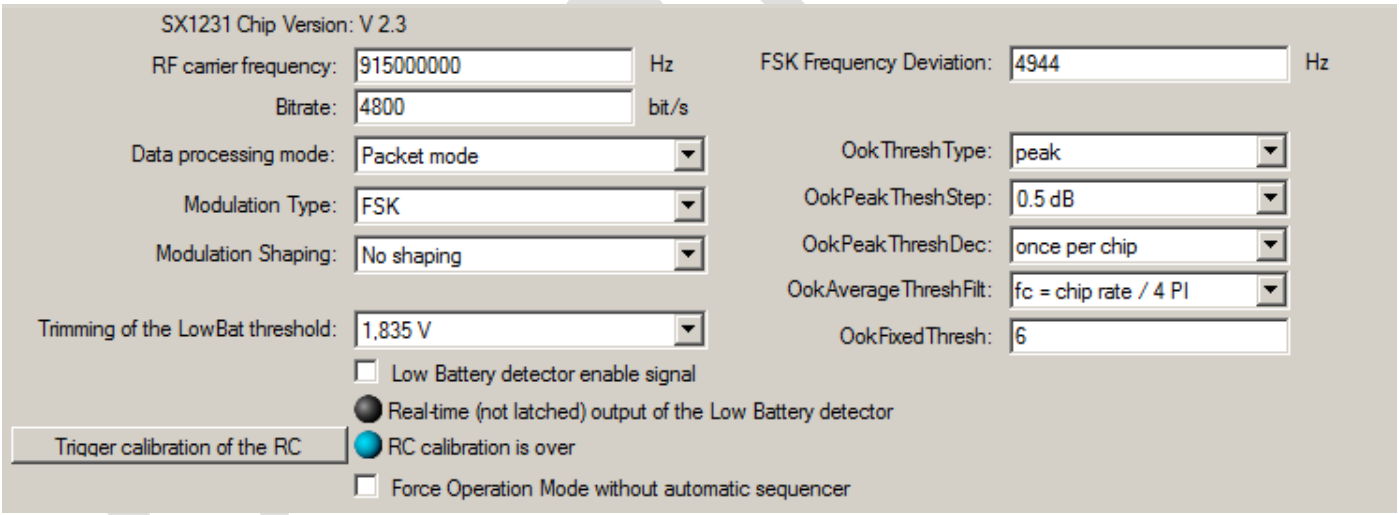
3.2 SAVE AND LOAD REGISTER CONFIGURATIONS

Configuration->Save
This menu point can be used to export the current register settings to a file.
Configuration->Load
This menu point can be used to restore register settings from a previously saved file or one of the example configurations.
Configuration->Save on Device
This menu point can be used to save the current register settings on the device. The saved settings will be used in standalone mode. When testing with the EM1200 boards both should be set to the same configuration.
Configuration->Reset Registers->Recommended
Reset the Registers to the firmware default values. It might be necessary to change the Carrier frequency as the Software cannot distinguish between the Frequency variants of the used module.
Configuration->Reset Registers->Power ON
The Registers will be reset to the SX1231 Power ON Default values as listed in the Datasheet.

3.3 COMMON



In the common settings section it is possible to change

- Carrier frequency
- Bitrate
- Modulation type
- Modulation Parameters FSK and OOK

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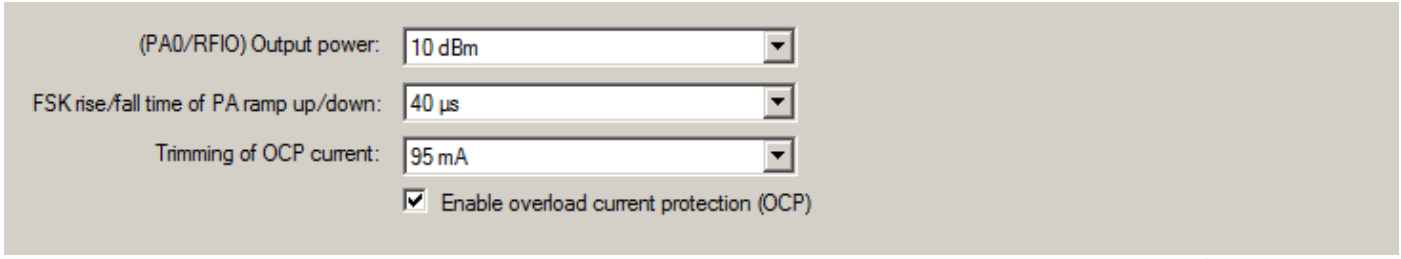
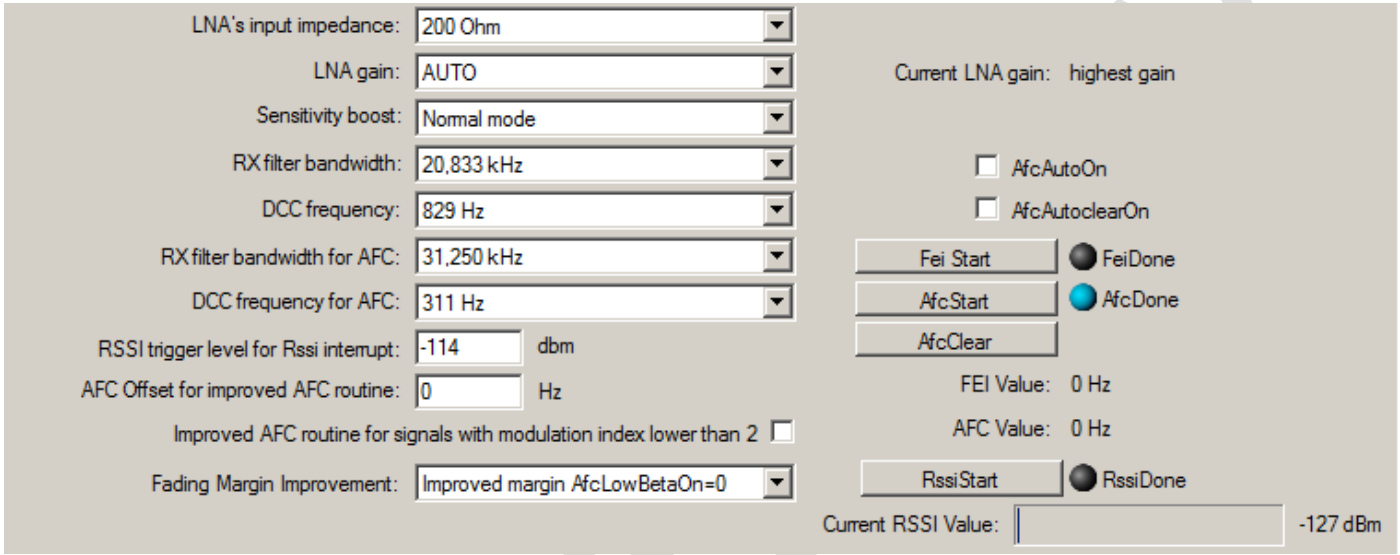
3.4 TRANSMITTER



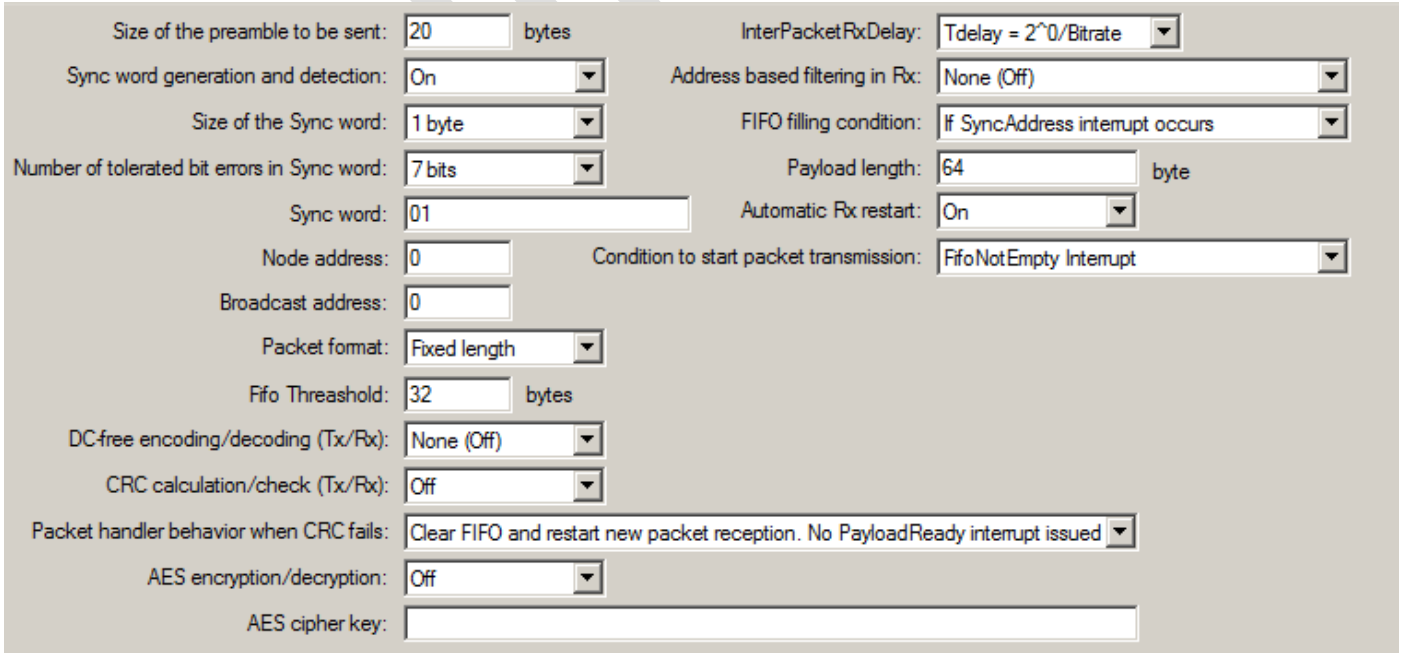
Here the transmitter settings can be changed.

3.5 RECEIVER



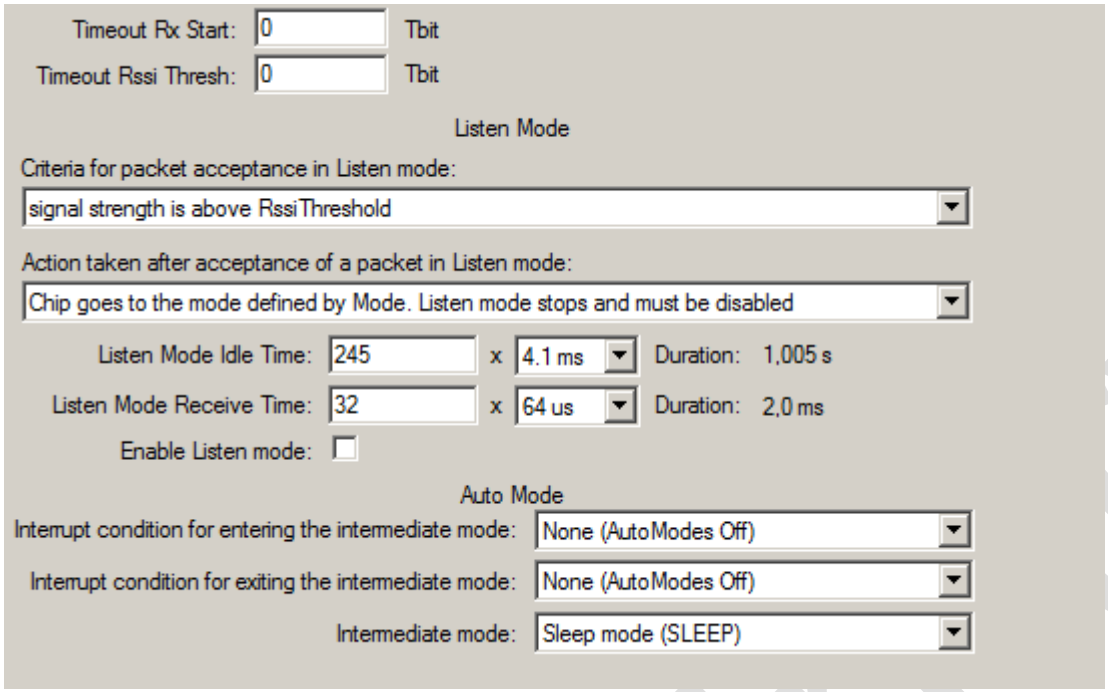
This subsection allows modification of the LNA-, RX filter-, RSSI- (Receive Signal Strength Indicator), AFC- (Automatic Frequency Cancelation) settings.

3.6 PACKAGE FORMAT



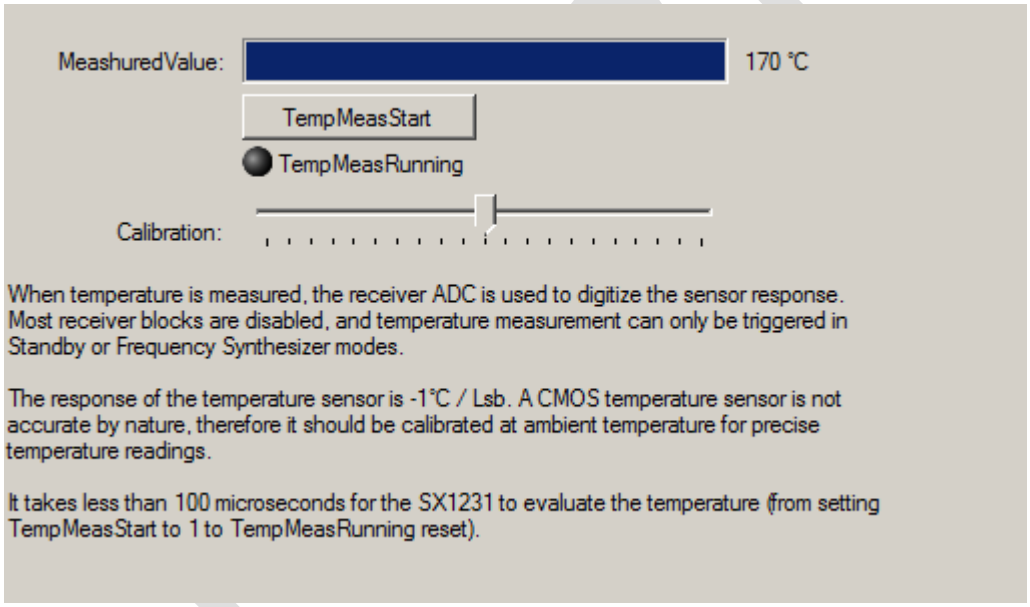
This section describes the packet format e.g. the criteria for package detection, acceptance, CRC, data representation.

3.7 PACKET HANDLING


Timeout Rx Start: 0 Tbit
Timeout Rssi Thresh: 0 Tbit
Listen Mode
Criteria for packet acceptance in Listen mode:
signal strength is above RssiThreshold
Action taken after acceptance of a packet in Listen mode:
Chip goes to the mode defined by Mode. Listen mode stops and must be disabled
Listen Mode Idle Time: 245 x 4.1 ms Duration: 1,005 s
Listen Mode Receive Time: 32 x 64 us Duration: 2,0 ms
Enable Listen mode:
Auto Mode
Interrupt condition for entering the intermediate mode: None (AutoModes Off)
Interrupt condition for exiting the intermediate mode: None (AutoModes Off)
Intermediate mode: Sleep mode (SLEEP)

In this section the Listen Mode and Auto Mode can be configured.
Also the timeout values for Packet reception can be configured here.
Using these autonomous chip operation modes is recommended for applications that require energy efficient operation.

3.8 TEMPERATURE SENSOR


MeashuredValue:
170 °C
TempMeasStart
TempMeasRunning
Calibration:
When temperature is measured, the receiver ADC is used to digitize the sensor response. Most receiver blocks are disabled, and temperature measurement can only be triggered in Standby or Frequency Synthesizer modes.
The response of the temperature sensor is -1°C / Lsb. A CMOS temperature sensor is not accurate by nature, therefore it should be calibrated at ambient temperature for precise temperature readings.
It takes less than 100 microseconds for the SX1231 to evaluate the temperature (from setting TempMeasStart to 1 to TempMeasRunning reset).

This section gives access to the temperature sensor embedded in the SX1231.

3.9 REGISTERS

Addr	Value	Addr	Value	Addr	Value	Addr	Value	Addr	Value	Addr	Value
0x00	FF	0x10	23	0x20	00	0x30	01	0x40	FF	0x58	1B
0x01	10	0x11	9C	0x21	00	0x31	01	0x41	FF	0x59	09
0x02	00	0x12	09	0x22	00	0x32	01	0x42	FF	0x5F	08
0x03	1A	0x13	1A	0x23	00	0x33	01	0x43	FF	0x6F	30
0x04	0B	0x14	40	0x24	DA	0x34	01	0x44	FF	0x71	00
0x05	00	0x15	B0	0x25	42	0x35	01	0x45	FF		
0x06	51	0x16	7B	0x26	77	0x36	01	0x46	FF		
0x07	E4	0x17	9B	0x27	D9	0x37	00	0x47	FF		
0x08	C0	0x18	88	0x28	44	0x38	40	0x48	FF		
0x09	00	0x19	54	0x29	E4	0x39	00	0x49	FF		
0x0A	41	0x1A	84	0x2A	00	0x3A	00	0x4A	FF		
0x0B	00	0x1B	40	0x2B	00	0x3B	00	0x4B	FF		
0x0C	02	0x1C	80	0x2C	00	0x3C	A0	0x4C	FF		
0x0D	92	0x1D	06	0x2D	14	0x3D	02	0x4D	FF		
0x0E	F5	0x1E	10	0x2E	87	0x3E	FF	0x4E	01		
0x0F	20	0x1F	00	0x2F	01	0x3F	FF	0x4F	00		

Here the raw register values of the SX1231 can be read and written.

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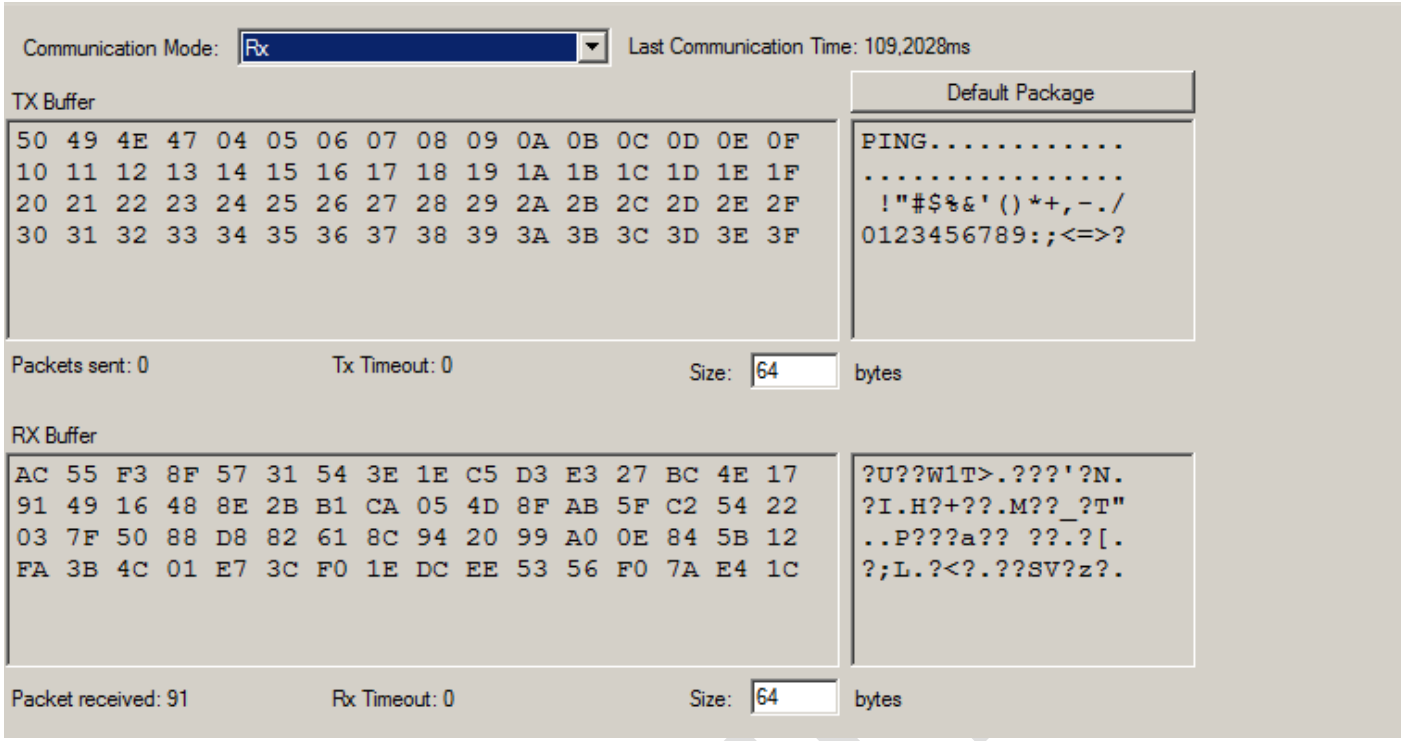
3.10 DATA PROCESSING


Communication Mode: Rx
Last Communication Time: 109,2028ms
TX Buffer
Default Package
50 49 4E 47 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F
20 21 22 23 24 25 26 27 28 29 2A 2B 2C 2D 2E 2F
30 31 32 33 34 35 36 37 38 39 3A 3B 3C 3D 3E 3F
PING.....
.....
!"#$%&'()*+,-./
0123456789:;<=>?
Packets sent: 0
Tx Timeout: 0
Size: 64
bytes
RX Buffer
AC 55 F3 8F 57 31 54 3E 1E C5 D3 E3 27 BC 4E 17
91 49 16 48 8E 2B B1 CA 05 4D 8F AB 5F C2 54 22
03 7F 50 88 D8 82 61 8C 94 20 99 A0 0E 84 5B 12
FA 3B 4C 01 E7 3C F0 1E DC EE 53 56 F0 7A E4 1C
?U??W1T>.???'?N.
?I.H?+??.M??_?T"
..P???a?? ??.?[.
?;L.?<?.??SV?z?.
Packet received: 91
Rx Timeout: 0
Size: 64
bytes

The RF communication can be tested here, the following modes are supported:

- **IDLE**: No RF communication is in progress, the TX Buffer on the µC can be modified.
- **TX**: Send packets containing the TX Buffer as payload.
- **RX**: Received packets are stored in the RX Buffer.
- **PING**: in this mode the Communication in Standalone master mode can be observed.
- **PONG**: in this mode the Communication in Standalone slave mode can be observed.
- **Request**:
  - One packet is sent
  - Wait for reception of one packet or a receive timeout.
- **Response**: After receiving a valid packet the TX Packet will be sent

Please be aware that for Request/Response the time required for the USB Communication delays the switching time from RX to TX and vice versa.

The register monitoring may disturb the firmware when handling larger payload sizes and higher bitrates. The monitoring should be disabled in this case.

Restriction on the Firmware:

- Continuous Mode is not supported.
- Unlimited length package format is not supported.
- Listen mode/Auto mode are not supported.
- Packet format without Syncword recognition is not supported.

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Version	Create Date:	Creator	Changes
01 preliminary	03.11.14		Create new Datasheet
02 preliminary	18.12.14		Update with new Details
03 preliminary	19.12.14		Update with new Details

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